

# ESA-105 Final Public Report

## Introduction

The DaimlerChrysler Corporation's St. Louis Assembly Facilities/Complex located in Fenton, MO consists of North and South assembly plants. The North plant manufactures the world class Ram truck and the South plant manufactures the world class minivans. Both the plants receive their utilities (steam, chilled water and compressed air) from the Powerhouse, which is located in the North plant. The Powerhouse has four natural gas water-tube boilers that produce 140 psig saturated steam. Two of these boilers are also configured to burn landfill gas along with natural gas. The total steam generation capacity at the Powerhouse is ~380 Mlb/hr. Steam generation varies significantly all around the year. Peak steam generation during summer (May - September) is ~160 Mlb/hr. Average steam generation during the shoulder months (October, April) and winter (November – March) periods is ~50 Mlb/hr. During extreme cold weather conditions, steam generation could peak as high as 200 Mlb/hr. The Powerhouse also has three steam condensing turbine driven chillers (4,300 RT each) along with another 12 electric motor-driven chillers (~25,000 RT total).

## Objectives of ESA

The main objectives of the ESA were as follows:

- Understand and identify steam system energy savings opportunities for the overall North Assembly Plant and focus on a couple of areas to estimate the magnitude of potential improvement opportunities
- Use the DOE Steam tools such as the Steam System Scoping Tool (SSST), Steam System Assessment Tool (SSAT) and the 3E Plus insulation software to model the steam system at the North Assembly Plant
- Assist the Daimler Chrysler plant team to familiarize and have the ability to use all of the above mentioned tools to identify energy efficiency improvement opportunities at the plant and quantify the potential energy savings associated with the steam system

## Focus of Assessment

The Steam ESA focused on the Powerhouse that includes steam boilers and chiller plant (steam-turbine driven and electric motor driven chillers). The ESA also focused on the plant process and space heating steam end-use.

## Approach for ESA

The ESA core plant team included Ken Peebles, Bob Wright, Shelley Sullivan, Jeffery Huie, Michael Burke and Jeff Zupanovich. These personnel have varied responsibilities for the North plant Powerhouse and the DaimlerChrysler Corporation that includes BestPractices, Engineering, Operations, Maintenance, Reliability and Control. The ESA core team completed the Steam System Scoping Tool (SSST) on the steam system and sent it to the ESA expert prior to the start of the ESA. The steam system at the North plant Powerhouse consists of four steam generating water-tube boilers. The plant team first decided to focus and understand the overall steam generation at the plant. After having a good understanding of the steam generation area, the team then focused on end-uses and areas to implement the SSAT and identify energy saving opportunities. Several members of the ESA Core Team have downloaded the Steam System Assessment Tool (SSAT) to quantify potential steam system efficiency opportunities for natural gas and steam energy savings. The load profile of the plant was developed based on annual data (2005) from the Powerhouse. A 1-pressure header steam system model was used to study the impact of potential improvement opportunities at the plant. Both real-time and historical data was collected from the plant DCS system during the ESA. The quantified information for the potential improvement opportunities is presented in this final report.

## General Observations of Potential Opportunities

There is a significant level of industry best practices in place at the DaimlerChrysler St. Louis Assembly plant, which is reflected in the score (63%) that the plant received on the SSST. Based on the Steam ESA, the majority of the cost savings opportunities exist in the generation and end-use areas. It has to be noted that due to the complexity of the plant steam and chiller load balance and the constraints of proximity, headers, electrical feeder limitations, etc., some of these opportunities may not be economically justifiable. Additional due diligence and engineering evaluations will be needed to firm up the potential savings opportunities and the capital expenditure associated with each opportunity.

### 1. Optimize boiler operation and load management strategy (Near term)

The powerhouse boiler operation is configured to ensure a very high reliability of operation. But there is an opportunity whereby the boiler plant operation can be optimized to save energy without sacrificing any system reliability. This can be achieved by operating one less boiler than the current operating strategy, especially in the summer months. Data collected from the plant showed that typically three out of the four boilers were operating at less than 40% and the fourth boiler around 50-60% of full load capacity during the summer months. This reduces

overall boiler plant efficiency. There are significant part-load losses that can be eliminated by firing fewer boilers closer to full load and design conditions to meet the steam demand.

**2. Raise boiler operating pressure in summer (Near term)**

During the summer months, three steam condensing turbines drive centrifugal chillers that produces cooling (chilled water) for the South plant. The steam rate (lb/hr/hp) reduces as the inlet steam pressure increases. This would be very beneficial to the plant and can be used as a strategy to improve the overall powerhouse efficiency during the summer months. When steam is just used for heating during the winter months, there is no incentive to operate at the elevated pressure. This opportunity evaluates raising the steam header pressure to 150 psig from 140 psig, which is the current operating pressure.

**3. Reduce flue gas oxygen in boiler #1 (Near term)**

Based on historical data, it has been found that boiler #1 operates with an excess flue gas oxygen level of ~7%. The optimized level of operation is expected to be around 3.5%. It is not clear if the sensor calibration is incorrect or if there is a sensor and/or automatic oxygen trim controller malfunction. This opportunity will result in rectifying this problem and increasing boiler #1 efficiency.

**4. Enhance feedwater economizer on boiler #1 (Medium term)**

Since boilers #1 and #4 have the capability to burn landfill gas, they collect most of the operating run-hours. Historical operating data shows that the final flue gas exit temperature of boiler #1 is ~100°F higher than the final flue gas exit temperature of boiler #4 at similar loads and feedwater temperatures. This difference can be due to one or both of the following factors: boiler #4 has an enhanced fin-tube economizer whereas boiler #1 has a plain tube economizer, boiler #1 economizer may be fouled. This opportunity investigates the boiler #1 economizer and replaces it with an enhanced fin-tube unit or cleans the current economizer.

**5. Reduce boiler blowdown (Near term)**

Blowdown is managed manually at the powerhouse for each of the boilers. There have been some issues with the blowdown conductivity sensor. Investigation is required to determine the root-cause for its non-functionality. Nevertheless, based on historical data collection it is found that during summer with an extremely high condensate return (>90%), blowdown is well managed and is within 2% of feedwater. But for the rest of the year, since the boiler load drops, proper cycles are not maintained, especially on partly loaded boilers. This leads to excessive blowdown and that can be minimized by a proper protocol.

**6. Implement blowdown heat recovery (Near term)**

Currently, heat is recovered from the blowdown stream via a heat exchanger. But there have been operational issues that result in water hammer and a loss of steam from the blowdown flash to ambient. This system can be reconfigured by installing a blowdown flash tank upstream of the heat exchanger. The steam from the flash tank can be captured and used in the deaerator. Saturated hot water from this flash tank can then exchange heat with the make-up water in the currently available heat exchanger.

**7. Implement a steam trap management program (Near term)**

The last steam trap audit program done at the St. Louis assembly complex was almost 10 years ago. Using the SSAT model, the impact of an effective steam trap management program was modeled. This management program would include annual steam trap testing, updating the current steam trap database and replace/repair defective traps.

**8. Replace condensing steam turbine w/electric motor (Medium term)**

There are three 4,300 RT condensing steam turbine centrifugal chillers at the Powerhouse. During summer, depending on the load, all three chillers are operated along with several other electrical chillers. It is extremely expensive to operate a condensing steam turbine given the utility rates at the Powerhouse. This opportunity replaces one of the condensing steam turbines with an electric motor. This will ensure that the installed cooling capacity at the plant will be the same as before. Alternatively, the same opportunity can be realized by shutting down one of the condensing steam turbine driven chillers. The cooling load of that unit can be split among the remainder of the steam turbine driven chillers and the electrical machines. This is possible to do since the Powerhouse does have excess chiller capacity and more importantly, all the operating chillers are not fully loaded. There are several additional efficiency improvements due to this opportunity but are not accounted in the savings calculations – chillers operating more closer to full load, cooling tower is debottlenecked, etc.

**9. Other opportunities & BestPractices**

Due to the limited time and scope of the steam ESA, not all the opportunities that came up during the ESA were developed and modeled using the DOE Steam Tools. Some of them need additional due diligence to identify the potential savings opportunity. Nevertheless, they are listed in this category and will be pursued in the near future.

#### Optimize landfill gas configuration (Near term)

A bias setting in the control logic can very easily influence the way landfill gas is distributed between boilers #1 and #4. Given the fact, that boiler #1 has a lower efficiency than boiler #4, it may be beneficial from a cost perspective to send more landfill gas to boiler #1 than to boiler #4, thereby reducing the amount of net natural gas required to produce a given amount of steam.

#### Capture vented steam energy (Near term)

Vented steam from the receiver vents, deaerator can be captured and condensed or used to heat process water or domestic water.

#### Waste heat recovery from thermal oxidizer stack for reclaiming paint sludge (Long term)

The paint shops in the North and South assembly plants produce paint sludge that has to be dried to a certain percentage (<55% moisture) and then reclaimed. The paint sludge is originally at ~75% moisture content by weight. One opportunity is to recover the waste heat from the combined thermal oxidizers stack and use that to facilitate the drying of this sludge. The stack gases (~65,000 cfm) exiting at ~400°F contain a large amount of heat (~7.5 MMBtuh) which can be used to dry the paint sludge to the specifications required. This paint sludge has a calorific value and will be sold as a fuel after the specifications are met.

#### Optimize operation of the chiller plant by load management (Near term)

Similar to the boiler plant management and loading strategy, there exists an opportunity to optimize the operations of the chiller plant. Operating multiple chillers that ramp up and down all at the same time may not be the most optimum configuration considering these are centrifugal chillers and may not exhibit the highest efficiency at part-load conditions. Each chiller may also have an operating sweet-spot. Also, some of the chillers have an inherent higher efficiency because they have an economizer and are two-stage systems instead of single-stage units.

#### Periodic boiler tuning (BestPractice)

The Powerhouse boilers have smart instrumentation that have self-calibration capabilities and the oxygen sensors have a long life before they need to be replaced. Nevertheless, as a bestpractice it is routine to do a burner tune-up and a performance test (high, medium and low fire) once a year. This predictive maintenance practice can be done immediately after the annual boiler safety inspection and hence, wouldn't result in any loss of production.

#### Periodic boiler tube inspections (BestPractice)

The Powerhouse boilers #1, #2 and #3 have been operating for several years. Some investigation needs to be done to determine if there is any build-up of scale in the tubes over all these years. Scaling of tubes is not only detrimental to boiler efficiency but can lead to tube wall overheating and eventually to tube failures. A boroscope investigation during an extended shutdown would be a good bestpractice to setup as a predictive maintenance.

#### Monitor and trend utility equipment efficiency (BestPractice)

There is a significant amount of instrumentation on all the equipment in the Powerhouse. Data from these instruments is transmitted to the central control station. A large portion of the data is also stored in a historian and available for review. Monitoring and trending critical data and certain evaluated parameters can be an extremely important tool for fault detection and diagnostics of boilers, chillers, air compressors. This is analogous to a doctor looking at the ECG or other data that is being continuously recorded off the patient.

### **Management Support and Comments**

From a corporate standpoint, DaimlerChrysler Corporation has set a target of 2% annual reduction in the energy used per unit produced. At the St. Louis Assembly complex, there exists an Energy Champion who is defining and helping to meet the energy reduction goals for the plant. The plant personnel work closely with the operations to develop BestPractices and optimize the operation of the Powerhouse. The plant management has provided full support to the ESA Team to capture any and every economically justifiable opportunity. Plant personnel spent three days working with the ESA Specialist and will continue to work on identifying projects plant-wide thereby re-affirming their goals and strategy.

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The definitions for Near Term, Medium Term and Long Term opportunities are as follows:

- ❑ Near term opportunities would include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
- ❑ Medium term opportunities would require purchase of additional equipment and/or changes in the system such as addition of recuperative air preheaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
- ❑ Long term opportunities would require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.